

Possible computer systems for future hardwood mills

Are computer vision systems and automated or computer-aided edging and trimming systems in the future of hardwood sawmills? The answer is yes

BY PHILIP A. ARAMAN



Computer vision systems and automated or computer-aided edging and trimming systems are in the future of the hardwood sawmill industry for many reasons. They include improved recovery, increased productivity, improved marketability, reduced costs and accurate lumber grading.

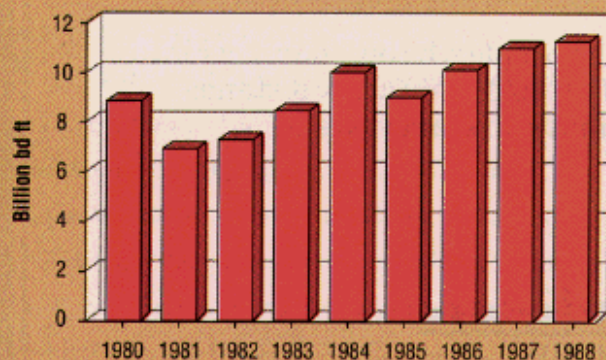
Hardwood sawmillers are facing many different situations and some confusion. Production has been increasing to a reported 11-plus billion bd ft (Fig. 1) due to increasing domestic and exports markets (Fig. 2). Low-grade hardwood sawtimber resources continue to be a major problem because they comprise a majority of our available material in the woods. Inconsistent product quality and less than optimal processing are problems for many producers. Log costs have been increasing while lumber prices seem to have stabilized.

Hardwood sawtimber resources have been increasing (Fig. 3) and quality may be getting better. With the increased demands, however, keeping enough logs in saw-

mill yards is not getting easier. In recent surveys (Bush 1989; Sinclair, Bush and Araman 1989), hardwood lumber customers reported several major concerns: (1) inaccurate lumber grading by producers; (2) inconsistent thickness of lumber; and (3) poor quality of the lumber they were purchasing. To keep and satisfy hardwood lumber customers, hardwood sawmillers need to improve the accuracy of their lumber grading and provide consistent products. They also need to get more value out of the logs they are processing.

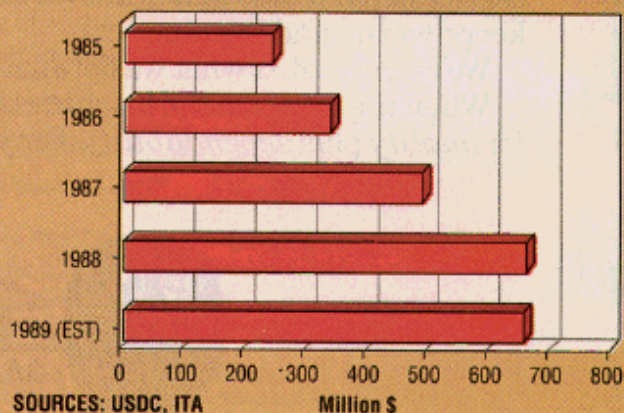
Research is underway to help our industry reduce costs, increase product volume and value recovery, and market more accurately graded and described products. The research projects are team efforts to help the hardwood sawmill industry automate with computer vision systems and computer-aided or controlled processing. The research teams include scientists with the Northeastern, Southern and Southeastern Forest Experiment Stations of the USDA Forest Service, Michigan State University, Virginia Tech University and West Virginia University.

FIG. 1—U.S. hardwood lumber production, 1980-88 (billion bd ft)



SOURCE: National Forest Products Assn.

FIG. 2—U.S. hardwood lumber exports, 1985-88, 1989 est. (million dollars)



SOURCES: USDC, ITA

Million \$

Computer vision research in grading and analysis

The goal of this research is an automated system to grade lumber and to describe potential furniture cuttings in hardwood lumber. To do this, defects must be located, properly sized and identified, and board outlines must be determined. Then a computer program is needed to grade the boards, using National Hardwood Lumber Assn. grading rules.

A separate program is needed to determine the possible furniture cuttings located in the boards. This last program could also determine if it would be better to use rip or crosscut first processing for each board. The resulting system would generate packages of computer graded and marked lumber, including information on potential cuttings, and the best initial rough mill processing step.

The basic research on detection, sizing, and identification by computer vision is underway. The status of this work was presented at FOREST INDUSTRIES' 3rd International Conference on Scanning Technology in Sawmilling (Connors, Cho and Araman 1989).

Our challenge is to create one general analysis method for the many different hardwood species. This method must be computationally simple enough for real-time industrial processing.

Computer detection, analysis and identification of defects on rough lumber with a vision system represent a complex problem. Lumber changes in visual appearance as the surface dries. Outside storage and drying can cause color changes, along with dirt problems. Surfacing would take care of most of these problems, but we need to grade rough rather than surfaced lumber. Our research is addressing these problems.

We have recently built a prototype image system to collect data from 4-ft-long boards. The complete system includes a material handling device, a line scan camera, special lighting, a customized data transfer device and a computer system. The system is working. We are designing the image system to process 16-ft-long boards at a realistic industrial processing speed.

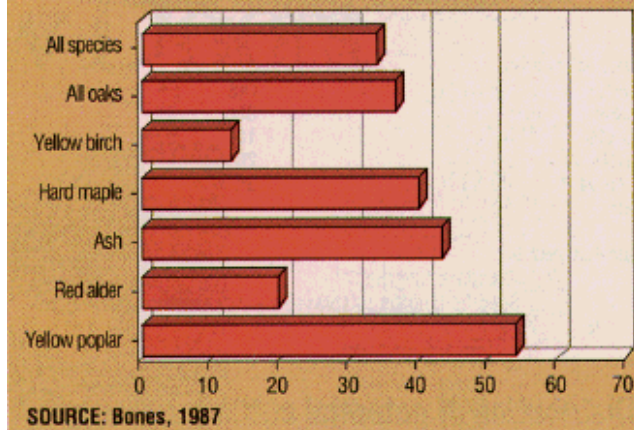
A computer program is available for grading hardwood lumber by the standard rules of the National Hardwood Lumber Assn. (Klinkhachorn and others 1988). The program is being enhanced to increase the rate of computer processing to a practical industrial speed. We are changing the standard shape of defect presentation from rectangular to any polygon to reduce the data needed to describe defects or void areas.

The program is being written in C to increase computational speed to compensate for the additional complexity arising from nonrectangular defect presentations.

Another computer program determines the cuttings available in each board. It also compares the yields in cuttings achieved by crosscutting or ripping the board as the first cut-up process. The program is called CORY (Brunner and others 1989). Refinements to CORY may be necessary to increase processing flexibility and computer speed.

The information provided from the system for packages of lumber will be similar to that shown in Fig. 4. Grade mix, total board footage, potential yield in cuttings and potential distribution of cuttings are on the tally sheet. As shown in Fig. 4, the simulation program can calculate the cuttings in standard or specific lengths. Output informa-

FIG. 3—Percent change in some hardwood sawtimber resources from 1977-1987



tion can be modified and expanded easily. Individual board information will also be available.

With the above capabilities, lumber producers could provide the accurately and consistently graded material desired by end users. They could also provide extremely worthwhile information on potential cuttings and processing to end users. End users of hardwood lumber could also use the system to determine which boards should be crosscut or ripped first and the potential cuttings. It could also help determine the proper lumber grade or grade mix that should be used for different situations.

In an extension of our computer vision research, we plan to develop a computer vision grading system for pallet parts. Grading and pallet part separation systems are needed to produce more reliable pallets from low-grade solid wood. Vision grading is one alternative in pallet part quality separation. The grading could be done by sawmillers who want to produce and market pallet parts. Pallet reducers could also grade and separate parts before pallet construction.

Computer-aided manufacturing: edging and trimming

Decisions on whether to edge and trim many edged boards or to trim other sawmill boards can have a major effect on the performance of a sawmill. Optimum decisions are difficult because of the complexities of the grading rules, the inability of an operator to include lumber prices in his decision, operator skills, and operator fatigue and/or lack of interest at times.

A recent preliminary study has shown that an operator could have increased the value of the lumber produced by 19% with optimal processing. We are conducting further studies to determine potential inefficiencies. Poor edging and trimming are definite problems in hardwood sawmills. Wasted dollars are being chipped every day.

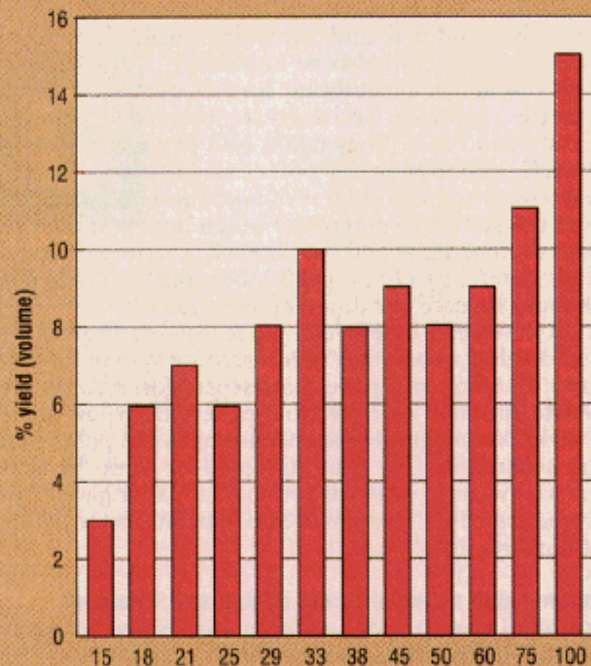
We are working to develop a semi-automatic or computer-aided edging and trimming system. The system takes a quick picture and displays a board on the bottom half of a monitor. The board dimensions are determined and a potential grade is assigned. The computer tells the operator how much can be trimmed or edged to increase the grade and value of the board. The operator can decide

FIG. 4—Example tally sheet for computer analyzed lumber

Batch information		Grade mix	
Source	Hardwood Co.	FAS	5%
Species	Red oak	SEL	3%
Lengths	9 & 10	1C	67%
Thickness	5/4	2C	25%
Total bd ft	1500 bd ft	3C	
Date	1-15-90		

Potential yield in:
X Standard lengths
is Specific lengths (displayed below) (widths are random)
is 72%

Distribution of potential cuttings by length



where to cut the board. The computer will tell the operator if any further options are available. With the present setup, laser lights and corresponding sawblades would be positioned for the proper cuts.

This particular research will generate a low-cost system. Most hardwood sawmills cannot afford expensive systems. However, our next step, as our computer vision abilities expand, will be to develop a system totally operated by computer.

Automated processing of logs

To convert medium and low-grade logs to end products more effectively, we are conducting research to produce green dimension blanks directly from logs.

We are not stopping with any form of lumber. We hope to improve volume and value recovery while producing

higher value products. We are considering European, Japanese and U.S. processing techniques used in, or under development for, furniture rough mills.

Yields in green dimension cuttings will be determined in a cut-up simulation program while producing standard sizes determined in previous research (Araman, Gatchell and Reynolds 1982; Araman 1987). One set of standard dimension sizes is for the domestic and one is for the export market. Several log breakdown patterns will be tested. Some final processing system designs will include potential computer vision stations to make processing decisions after the initial log breakdown.

Automatic ripping and crosscutting with the image processing will be used to improve yields and reduce the number of workers needed. We also will design some small mills. These will be for plants desiring to add a low volume of logs to green-dimension facilities next to their existing sawmill.

The future for hardwood mills

Will computer systems in hardwood sawmills grade lumber and process material in the future?

We hope so. We are putting resources and research efforts into that prospect. We need the support of hardwood sawmill companies, industry associations and equipment manufacturers to accomplish our goals. We know positive results will move our industry further into the computer age, permitting it to improve product recovery and remain competitive in the world marketplace and with competing materials in the United States.

These systems will also improve utilization of our hardwood resources. We also hope more profitable use of our abundant low-grade sawtimber will be possible. ■

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THE AUTHOR is a research project leader for the Southeastern Forest Experiment Station, Virginia Tech University, Blacksburg, Va. His research focus is on automated primary hardwood processing and products from low-grade hardwood material and nonselect hardwood species. This paper was presented at the 1990 FOREST INDUSTRIES Clinic and Machinery Show, held in Portland, Ore.

